Production Increase When Hobbing with Carbide Hobs

LMT-Fette

STEERING PINION	
DP	**13.02556**
No. of Teeth	8
Helix Angle	13°
Pressure Angle	20°
Gear Width	1.039 inches
Gear O.D.	.779 inches

Tool	**HSS**	**Solid Carbide**
Dry/Wet	Coolant	Dry
O.D.	1.771 inches	1.771 inches
No. of Starts/No. of Gashes	1/11	1/11
LOC/Shift/Distance	4.606/4.015 inches	4.606/4.015 inches
Resharpenings/Tool Life	10/1686	10/2529
Technology		
Axial Travel	1.669 inches	1.669 inches
Surface Speed	85	320
Hob RPM	600	2260
Feed Rate	.035 inches	.035 inches
Time		
Main Time	.59 minutes	.16 minutes
Idle Time	.17 minutes	.17 minutes
Time/Piece	.76 minutes	.33 minutes
Costs		
New Hob	$987.65	$2,222.22
Per Regrind	61.72	216.04
Tool Costs/Piece	0.86	1.60
Machine/Hour	55.55	0.16
Machine Cost/Piece	0.70	0.31
Piece Part Cost	0.79	0.47
Hobs Produced/HR	63	145

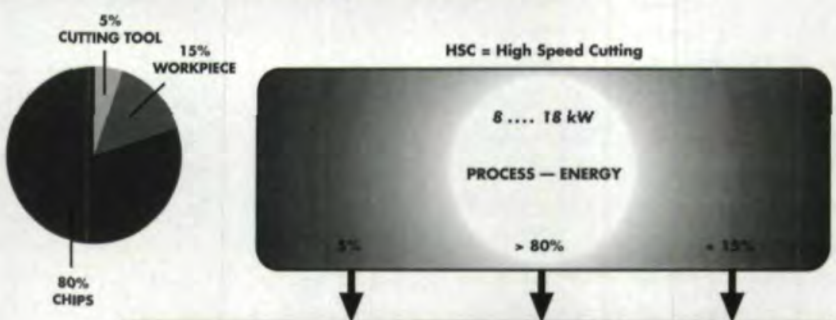
Table 1

We are all looking for ways to increase production without sacrificing quality. One of the most cost-effective ways is by improving the substrate material of your hob. Solid carbide hobs are widely used in many applications throughout the world. LMT-Fette was the first to demonstrate the use of solid carbide hobs in 1993 on modern high-speed carbide (HSC) hobbing machines. Since then the process of dry hobbing has been continuously improving through research and product testing. Dry hobbing is proving to be successful in the gear cutting industry as sales for dry hobbing machines have steadily been rising along with the dramatic increase in sales of solid carbide hobs.

Dry hobbing presents an advantage in itself as the oil does not have to be separated from the chips prior to disposal. Combining this advantage with the performance of solid carbide hobs will significantly increase surface speeds. The user will experience an increase in production, more available uptime for machining and a reduction in manufacturing costs. Examples for dry hobbing three separate gears are shown in Tables 1–3.

Solid carbide hobs are used primarily in machining gears and pinions in a range of 55–6.5 D.P. The design of the carbide hob consists of a solid carbide blank with bore and face drive slots.

HIGH SPEED — DRY HOBBING



	CUTTING TOOL	CHIPS	WORKPIECE
Temperature	approx. 140° to 212°F	approx. 932° to 1652°F	approx. 86° to 176°F
Effects	• Increased wear	• Chips too thin, red hot • Machine warms up	• Geometrical changes during hobbing
Measures	• Shift cycle • Coating is insulating factor	• Chip thickness according to hob design • Thermo-symm. Machine	• CNC corrections during hobbing

Fig. 1

LMT-Fette

LMT-Fette, Ohio, is a subsidiary of Wilhelm Fette GmbH. LMT-Fette offers an extensive line of custom design hobs manufactured to meet customer specifications.

Blanks can be produced up to 6" without any difficulty. A variety of smaller hobs can be manufactured with their shanks incorporated into a one-piece design. The configuration of the cutting tool depends mainly on the data of the gear to be machined and the desired chip thickness.

When dry hobbing first came into use, the majority of hobs were made from ISO 513 specified K grade carbide. This substrate has a tendency to cause chips to stick on the surface after the TiN coating has worn down. Since this substrate material cannot be used without a coated surface during dry machining, manufacturers have begun using the traditional P grades. P grades combine wear resistance characteristics with increased toughness, allowing higher surface speeds and increased tool life. New carbide grades and coatings are continually being developed which will provide longer tool life and an even more economic machining process (Chart 1, p. 22).

The cutting edges of a hob can reach temperatures up to 1700°F, causing scaling of the coated surface. In order to reduce scaling of the coated surface, leaving the substrate unprotected, four different coatings have been tested and proven acceptable (Chart 2, p. 22). According to ISO Standard 513, a good adhesion of the coating is of great importance, especially on the K grades. P grades however, require only one coating after the tool is produced. The tool can then remain in production even after it has been resharpened, and the coating on the flute face has been removed.

When all cutting parameters are specified correctly, 80% of the heat generated will be extracted directly into the chips (Fig. 1). During dry hobbing, tool wear occurs mainly on the relief side (flanks), unlike the case with high speed steel hobs, where the wear occurs primarily on the flute face. Special attention must be paid to possible *chipping on the cutting edge when the coating* surface is worn off. This is especially noticeable when using K grades. The abrasive wear on the substrate material is severe.

Without the protection of a coating, the edge wear increases as chips stick on the cutting edge. Edge wear needs to be monitored closely, as a rapid increase in wear occurs after approximately .009". As a general rule, carbide hobs should be resharpened prior to reaching an edge wear maximum of .006" (Fig. 2, p. 22).

The practice of dry hobbing has become common in many areas of the gear industry. Cost factors are greatly reduced by the elimination of the use of coolants and by eliminating the need to separate oil from chips. The primary savings gained from dry hobbing results from high

PLANET GEAR	
DP	16.93
No. of Teeth	15
Helix Angle	-23°
Pressure Angle	20°
Gear Width	.915 inches
Gear O.D.	1.1456 inches

Tool	HSS	Solid Carbide
Dry/Wet	Coolant	Dry
O.D.	2.362 inches	2.362 inches
No. of Starts/No. of Gashes	1/15	1/15
LOC/Shift/Distance	3.937/3.078 inches	3.937/3.078 inches
Resharpenings/Tool Life	10/1311	10/1966
Technology		
Axial Travel	1.740 inches	1.740 inches
Surface Speed	105	320
Hob RPM	560	1700
Feed Rate	.118 inches	.039 inches
Time		
Main Time	.35 minutes	.16 minutes
Idle Time	.07 minutes	.07 minutes
Time/Piece	.42 minutes	.25 minutes
Costs		
New Hob	$1,172.84	$2,962.96
Per Regrind	61.72	246.91
Tool Costs/Piece	0.12	0.25
Machine/Hour	55.55	55.55
Machine Cost/Piece	0.39	0.24
Piece Part Cost	0.52	0.48
Hobs Produced/HR	114	226

Table 2

SHIFT GEAR	
DP	12.7
No. of Teeth	31
Helix Angle	32°
Pressure Angle	16°
Gear Width	.71 inches
Gear O.D.	3.15 inches

Tool	HSS	Solid Carbide
Dry/Wet	Coolant	Dry
O.D.	3.54 inches	1.771 inches
No. of Starts/No. of Gashes	2/27	2/27
LOC/Shift/Distance	4.72/2.99 inches	4.72/2.99 inches
Resharpenings/Tool Life	8/994	10/1491
Technology		
Axial Travel	2.32 inches	2.32 inches
Surface Speed	95	320
Hob RPM	336	1131
Feed Rate	.160 inches	.140 inches
Time		
Main Time	.55 minutes	.21 seconds
Idle Time	.05 minutes	.05 seconds
Time/Piece	.60 minutes	.26 seconds
Costs		
New Hob	$1,481.48	$3,827.16
Per Regrind	61.73	246.91
Tool Costs/Piece	0.22	0.43
Machine/Hour	55.56	0.43
Machine Cost/Piece	0.55	0.24
Piece Part Cost	0.78	0.67
Hobs Produced/HR	80	200

Table 3

TOOL LIFE DURING DRY HOBBING

PIECE PART	HOB	CUTTING PARAMETERS
DP = 20 TEETH = 33 FACE WIDTH = .75 inches	SOLID CARBIDE GRADE P	VC = 300m/mm TOOL WEAR: max .004 inches

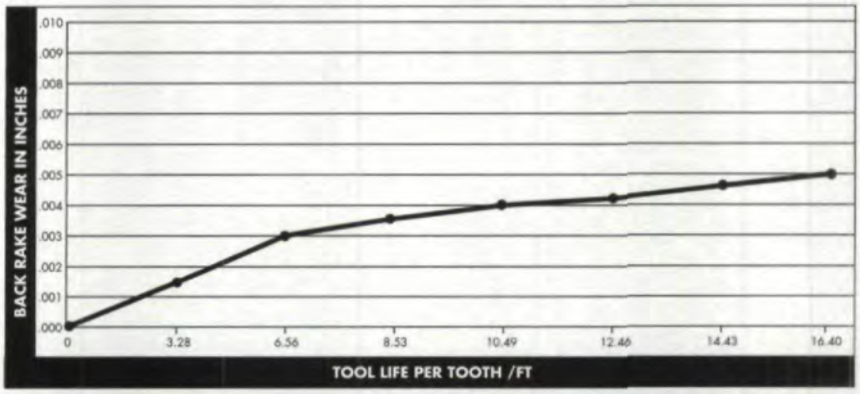


Fig. 2

Chart 1: Recommended Carbide Grades For Dry Hobbing

Carbide Grade	Chemistry of Carbide	Material to be Machined
P	WC TIC, Tac, NbC Co	• Long chip steel and cast steel components
K	WC Co	• Short chip cast iron and non-ferrous metals

Chart 2: Coatings

Coating	Microhardness by 20°	Advantages	Disadvantages
Ti (C,N)	3200HV	• Excellent wear resistance	• Increase of scaling above 752°F • Wear is noticable • Costly to recoat
(Ti, Al) N	2600HV	• High scaling resistance • Excellent wear resistance • Recoatable.	• Wear is noticeable • Reduced friction factor at the cutting surface with the risk of chip accumulation at the root
TiN	2200HV	• Moderate wear resistance • Recoatable • Wear is easliy recognizable due to coloring	• Increase of scaling above 932°F
LMT-Fette TiCN-Plus	N/A	• Excellent wear factor • Wear is easily recognizable due to coloring	• Increase of scaling above 932°F

Chart 3: Advantages & Disadvantages of Using Coolant

	Advantages	Disadvantages
Machine	• Chip transport	• Filtering units
	• Heat reduction	• Coolant pump
		• Coolant tank units
		• Additional use of electricity
Coolant		• Investment costs
		• Costs to separate oil from chips
		• Costs for stocking coolant
Environment		• Health risks
		• Dirty chips
		• Manufacturing and recycling problems
Machining Process		• Additional washing of piece parts

cutting speeds, which make the machining process much more economical than the traditional method of steel hobbing (Chart 3).

If the issue of chip separation from the oil is not a concern, then you can increase the tool life of a solid carbide hob by using oil as a coolant. The use of coolant will also have a significant influence on surface speed. Because of the high machining temperatures, the addition of coolant will create a thermal shock resulting in chipping of the cutting edges. When using a coolant in these conditions, surface speeds must be reduced to 800 to 850 sfm. Typical speeds for dry hobbing are in the 1100 sfm range.

Another new approach to optimizing tool life is using a minimum coolant supply of approximately one pint per hour. This procedure can still be considered "dry machining," as the piece parts and chips remain free of oil. Continued production increases utilizing the dry hobbing process can be obtained through improved carbide grades and new coating developments.

References:

1. Knoeppel, D. "Dry Hobbing for Gears and Transmission Components 36." Working Seminar, June 7–8, 1995.

Acknowledgment:

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